

**User's Guide to BENCOS--Lotus 1-2-3
Templates for Benefit-Cost Analysis**

by

Eric W. Crawford and A. Allan Schmid

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TEMPLATE FOR BENEFIT-COST ANALYSIS**

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USER'S GUIDE TO BENCOS -- LOTUS 1-2-3 TEMPLATES FOR BENEFIT-COST ANALYSIS*

By Eric W. Crawford and A. Allan Schmid

INTRODUCTION

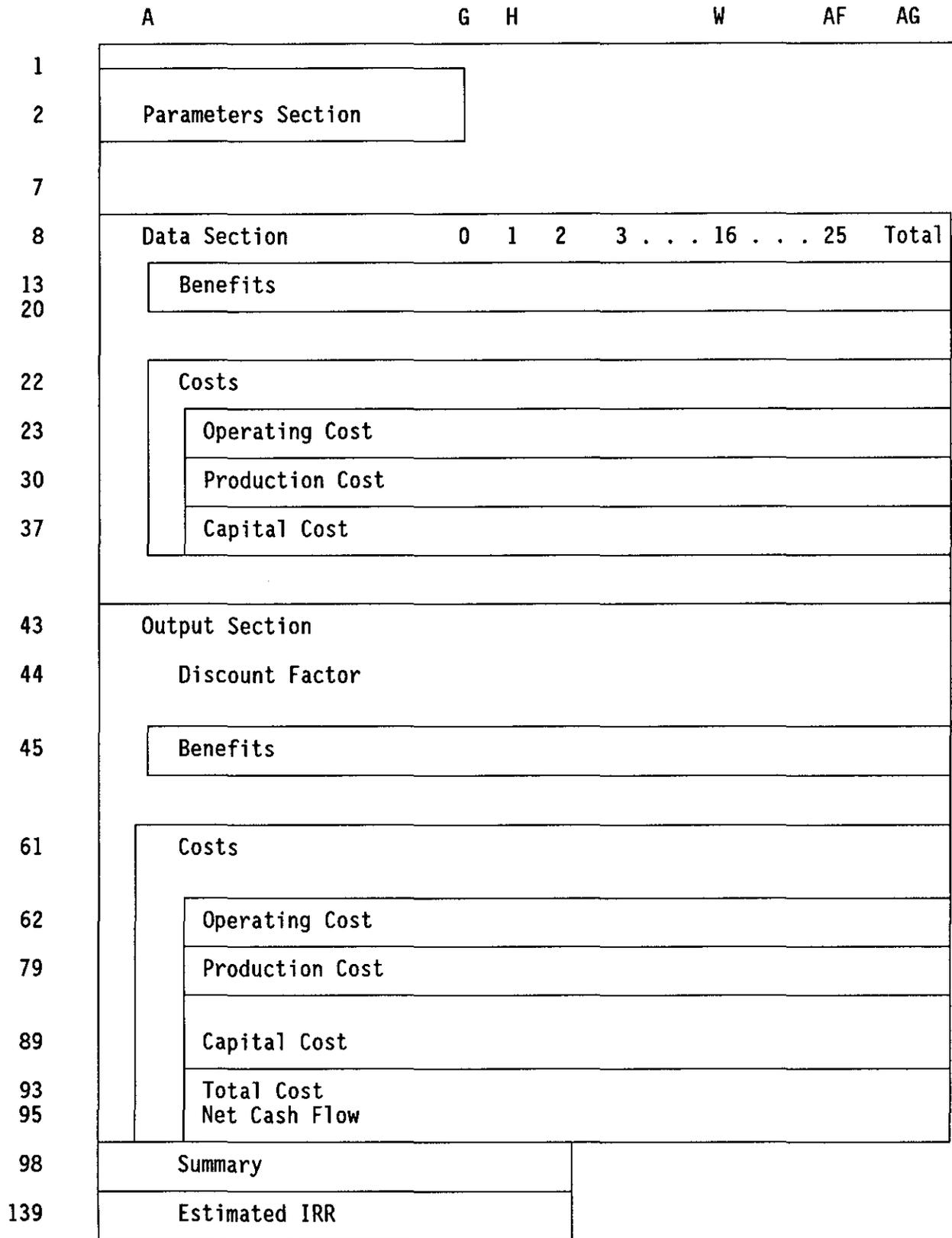
BENCOS is a Lotus 1-2-3 template designed for benefit-cost analysis. It is adapted from BENCOST, a FORTRAN program written for the CDC Cyber 750 by Robert F. Ranger, Robert D. Stevens, Roy A. Saper, and Ting-Ing Ho. The current form of BENCOS is designed for relatively small problems. BENCOS was written on an IBM PC microcomputer, but it will run on any IBM-compatible system using Lotus 1-2-3 (Release 1A, 2.0, or 2.01), or any other spreadsheet program that can read .WK1 format files. The most recent version of the basic template, which has been significantly revised with the assistance of Margaret Beaver, is called BENCOS2.WK1 (for Lotus 1-2-3 Release 2.01) or BENCOS20.WK1 (for Lotus 1-2-3 Release 2). The extended version, which allows project ranking by alternative investment criteria, is called SCHMID2.WK1 (or SCHMID20.WK1 for Lotus 1-2-3 Release 2). A diskette containing the four BENCOS templates, formatted for the IBM PC, can be obtained from MSU for \$15.00.

This guide assumes that the user is familiar with standard benefit-cost analysis techniques. A useful reference is J. Price Gittinger, Economic Analysis of Agricultural Projects, Second Edition, Baltimore, Johns Hopkins University Press, 1982. The concepts, structure, and calculations of BENCOS are generally consistent with those recommended by Gittinger.

This document begins with a description of the structure and capabilities of BENCOS, followed by instructions on how to use the template, and comments on possible modifications of the template.

*Revised version of "User's Guide to BENCOS--A SuperCalc Template for Benefit-Cost Analysis," Eric W. Crawford, Ting-Ing Ho, and A. Allan Schmid, Department of Agricultural Economics, Michigan State University, IDP Working Paper No. 14, 1984.

Figure 1. Diagram of BENCOS Spreadsheet



DESCRIPTION OF THE BASIC TEMPLATE

The BENCOS template is divided into four main sections: (1) Parameters Section, (2) Data Section, (3) Output Section, and (4) Summary. The abbreviated diagram of the spreadsheet in Figure 1 shows the row and column coordinates of these sections. A photocopy of the main sections of the spreadsheet is shown in Annex 1.

Parameters Section

Two parameters must be entered in this section: the interest rate to be used for discounting, and the user's definition of capital or scarce resource costs. BENCOS currently allows up to 25 years of benefits and costs.

Data Section

Information on benefits and costs is entered here. Note that it is incremental benefits and costs which should be used, i.e., the difference between with-project and without-project figures. BENCOS currently allows for two categories each for benefits, operating costs, production costs, and capital costs. Operating costs are general project-level overhead costs (e.g., administration, maintenance of central facilities, etc.); production costs are the costs of producing project output (e.g., fertilizer, seed, hired labor, or other farm inputs). Data for each category can be entered either as values, or as separate sets of units and prices. The exception is that capital costs must be entered as values.

The BENCOS format allows a choice between the two standard ways of phasing initial cost and returns. One alternative is to enter initial investment (capital costs) in Year 0, with initial operating and production costs and initial benefits (if any) beginning in Year 1. Values in Year 0 are not discounted. The second alternative is to ignore Year 0 and to begin entering all initial costs and benefits (if any) in Year 1. Values in Year 1 are discounted by one year.

Prices may be entered directly for each year, or they may be projected automatically on the basis of a Year 0 or Year 1 price and an annual price compounding factor (defined by the user). A constant scale factor can also be defined for use in sensitivity analysis. The use of these factors is explained below under "Entering Parameters and Data."

Output Section

This section first shows the discount factor for each year, based on the user-specified interest rate. Subsequent rows show the benefits and costs entered earlier by the user, the effect of the scale factor (if any), and the final values obtained as the product of price times quantity. The present value of the benefit and cost streams is also shown.

Total cost is the sum of operating, production, and capital costs. The "net investment" (sum of negative net cash flows), is calculated in a separate working space area (N98..P130) in order to calculate the second alternative definition of scarce resource costs (see "Summary" below, and Gittinger, 1982, p. 347.)

Summary

The summary section contains the present value of total benefits and costs. Net cash flow (undiscounted annual net benefits) and the present value of annual net benefits are also shown. Three discounted benefit/cost ratios are calculated: (1) gross benefit/cost ratio (Benefits divided by Total Costs); (2) (Benefits minus Production Costs) divided by (Operating plus Capital Costs); and (3) the net benefit/scarce resource cost ratio. The third ratio is defined as either (a) (Benefits minus Operating and Production Costs) divided by the user-entered Capital or Scarce Resource Costs, or (b) the sum of values in years where net cash flow is positive (benefits exceed total costs), divided by the sum of values in years where net cash flow is negative.

Lastly, the internal rate of return is estimated by interpolation based on calculation of net present value at successive 5 percent intervals (up to 150 percent) until NPV turns negative. More exact estimates of IRR are also given using (a) interpolation over a 1% interval, and (b) the Lotus 1-2-3 @IRR function (only valid if benefits and costs start in Year 1).

HOW TO USE BENCOS

Loading the Template

First, load Lotus 1-2-3 into memory. It is generally sufficient to enter 123 from the A> prompt (if the Lotus 1-2-3 system disk is in the A drive), or from the C> prompt (if you are in the subdirectory which contains

the Lotus 1-2-3 program). When the Lotus 1-2-3 trademark information appears, hit Return to obtain the spreadsheet (not necessary with Release 2.01). Then, load BENCOS into the spreadsheet as follows: type /FR and 1-2-3 will ask for the name of the file to load; then type (for example) BENCOS2.WK1 and hit Return. Note: Loading and initial calculations may take up to one minute (depending on your computer and version of 1-2-3), during which the "Wait" message appears at the top. The titles and instructions will be at half-intensity on the screen because they are protected. Data you enter will be at full intensity.

Entering Parameters and Data

Note: Dashes are used to indicate each cell in which data may be entered. (BENCOS20 contains zeroes in place of the dashes. LOTUS 1-2-3 Release 2 requires this version.) These dashes will be replaced by the numbers you enter.

Step 1: Enter the interest rate for discounting (in decimal form, e.g., enter 15% as .15) in cell E3.

Step 2: Enter either 1 or 2 in cell E5 to indicate your desired definition of capital or scarce resource costs. (See the "Summary" section above.)

Step 3: Enter your benefit and cost data.

There are three sets of data which are entered in the same way: benefits, operating costs, and production costs.

Note: (a) With a column width of 9, and using the \$ format, the output section allows room for only 5 digits to the left of the decimal point, so you should define your data as necessary (e.g., thousands or millions).

(b) Be careful to enter your data in the correct row and column. Otherwise, the program will not recognize what you have entered. Inspecting a print-out of your input data is a good way to check this.

- (1) Constant scale factor: You may leave this blank initially. A figure may be entered later when you want to do sensitivity analysis. Entering 1.10 will cause the corresponding type of benefit or cost to be increased by a constant 10 percent for all years. A scale factor of 0.95 would reduce your numbers by 5

percent for all years. A scale factor of 1.0 will result in no change.

(2) Price compounding factor (PCF):

- (a) If you are entering your benefits or costs as values, enter 1.0 for the price compounding factor and 1.0 as the price in Year 1 (or Year 0 if benefits or costs begin then).
- (b) If you are entering benefits or costs as units, in which case you need to enter a price per unit, you have two options:
 - (i) enter your own price value for each year, leaving the PCF blank; or
 - (ii) enter an initial price in Year 0 or Year 1 and a price compounding factor. Prices for subsequent years will then be projected using this compounding factor. (Specifically, price in Year 1 will equal price in Year 0, if any; price in Year 2 will equal price in Year 1 times the PCF; price in Year 3 will equal price in Year 2 times $(PCF)^2$, and so on.)
- (c) Sensitivity analysis involving compounded increases or decreases may be performed later by changing the PCF.

(3) Units and Prices of Benefits and Costs, excluding Capital Costs:

Two options are available.:

- (a) To enter benefits or costs as values, enter your numbers in the units row and then enter a price of 1 in the initial year [see Step 3 (2) (a)].
- (b) Alternatively, enter the units in the units row followed by prices in the price row [see Step 3 (2) (b)].

(4) Capital Costs: These must be entered as values.

(5) Note: The benefit/cost ratio calculations distinguish between operating and production costs. Organize your data entry with the definitions of the benefit/cost ratios in mind (see the "Summary" section above).

Step 4: Once the Data Section is complete, save your worksheet (see Step 6). Then initiate recalculation by hitting the F9 key. When this is complete, you can move around the worksheet to examine the results,

or print them out as indicated below. Row totals are shown in column AG.

Note: If your results do not look right, you may have made an error in entering your data. The best way to check for errors is to print out the data input section, as shown below.

Step 5: Printing out convenient blocks of the worksheet can be done with a macro (initiated by pressing Alt-P) which has the following options: C=complete worksheet; D=data; and S=summary. The macro assumes an IBM-compatible printer. Output is printed with compressed type and 8 lines per inch. The necessary right margin (180) is already set in the spreadsheet.

Step 6: Saving your worksheet. If you wish to save your worksheet at any point, enter the following command:

/FS BCname <return>

("BCname" is just a sample file name; it can be something else. Using "BENCOS2" would cause you to overwrite the blank worksheet stored by that name, which you do not want to do. Write down the file name you use here.)

Step 7: Recalling a previously saved worksheet (after loading 1-2-3) can then be done by typing, for example: /FR BCname <return>

MODIFYING THE TEMPLATE

There are several relatively straightforward modifications which the user may wish to make. Sections being modified would need to be unprotected first, and then reprotected.

More Years or Cost/Benefit Items

By inserting new rows, additional categories of benefits or costs could be accommodated. Some adjustment of formulas in the output section would be required. It is also possible to insert columns for additional years (between columns AE and AF, so that the formulas for row totals adjust automatically). Providing no columns are inserted before column P, this will not disrupt the spreadsheet.

Vertical Titles

Users who find it difficult to keep track of what row they are in when entering data may wish to fix the titles in column A. However, this would show only the first nine characters of the present titles, which would not be self-explanatory. This can be remedied either by rewriting the titles in condensed form, or (more simply) by inserting a new column of one-word acronyms in front of column A. Fixing the vertical titles would then keep this information on screen. Of course, the condensed titles would not have to be shown on any printed output. (Ranges in the \P print macro would need to be adjusted.)

Calculating Additional B/C Ratios

The calculation of one or more types of B/C ratios at 5% intervals could easily be added to the summary section (e.g., in columns K-M).

DESCRIPTION OF THE EXTENDED TEMPLATE

Introduction

Different investment criteria produce different project rankings because of different implicit rates of reinvestment of the net cash flow. The capital budgeting program described here implements a normalization procedure which explicitly controls the rate for reinvestment and makes all criteria produce the same ranking (for a given definition of scarce capital).

The extended template was developed to facilitate comparison of projects ranked by different investment criteria. The basic template illustrates such criteria as present value, present value ratios (with different definitions of the scarce resource), and internal rate of return. The extended template illustrates terminal values, normalized ratios and internal rates of return, and synthetic investment criteria involving different opportunity costs and benefit streams.

Second best conditions are often present in analysis. Capital rationing is common and the character of capital markets creates disequilibria in opportunities among groups. These conditions require explicit attention to the rate of reinvestment of capital flows. The theory of second-best investment criteria is developed in Schmid (1989, Ch. 9).

Parameters Section

After the Lotus 1-2-3 spreadsheet has been loaded, retrieve the template file depending on the version of Lotus you have: SCHMID20.WK1 for release 1.0 (displays zeros in empty data fields), or SCHMID2.WK1 for later releases (displays dashes in empty data fields).

The entry for "Interest Rate for Discounting" applies to Output Section I and would be sufficient for first-best analysis assuming equilibrium conditions. It is important for the extended analysis to define capital as the sum of negative cash flows, so enter "2" in cell E5. On the right-hand side of the screen is an additional input section entitled PART II (see Annex 2). Enter the Terminal Year as the year of benefits or cost of the longest-lived project to be compared with others. Enter the Interest Rate for Compounding Benefits (which will be the same as the Interest Rate for Discounting entered previously) and the Interest Rate for Compounding Costs. The rates in Part II control the calculation of terminal values in Output Section II. This allows different rates to reflect different opportunity costs for benefits reinvested and for cost streams. Use of different rates is part of the normalization calculation which makes the opportunity for reinvestment explicit. When cash flows are explicitly brought to terminal values, all investment criteria then produce the same ranking of projects. For a discussion of normalization, see Mishan (1976, Chs. 35-38).

Data Section

Enter data as directed in the above section entitled "How to Use BENCOS, Entering Parameters and Data."

Output Section I and Summary

This section of the extended template is identical to the basic template and includes the net present value ratio of benefits to costs (net benefit/scarcely resource cost). The computed value is in cell G135. The net cash flow is displayed on line 95. This line indicates the years when cash flow is negative and capital must be borrowed rather than all costs being covered by receipts. The net present value is shown in line 96 and the Summary-Output I section in the column labeled "Net Cash Flow." The Output

Section also displays the internal rate of return on line 145 computed at a 1% interval for interpolation.

Output Section II

This section shows the results of compounding all flows forward to the chosen terminal year. By explicitly choosing the rate for compounding, all projects are thereby "normalized." The compounding factor at the chosen rate for each year is displayed on line 154 for costs and line 156 for benefits. The compounding factor is given by $(1 + r)^t$. The relevant values are found as follows:

TVB (Terminal value of benefits)	AG157
TVK (Terminal value of capital costs)	AG160
TV B/K (Terminal value benefit-cost ratio)	F206
NTV (Net terminal value)	AG162 and F204
NIRR (Normalized internal rate of return)	G222

The NIRR is computed by calculating the present value of all negative cash flows (labeled -K). All positive cash flows are explicitly compounded forward to the terminal year. Thus the normalized or reconstructed cash flow is $-K, 0, 0, \dots, TVB$ and is shown in the section labeled Summary - Output II in column C under the heading Normalized Cash Flow. The NIRR is the rate of interest which reduces this normalized cash flow to zero. Once the normalization has been done, the terminal values can be expressed in present value terms and present value ratios computed. Ranking of projects by these normalized present value ratios will be identical to the ranking by NIRR (which is not true for ordinary present value ratios and IRR).

The effect of choosing different kinds of cost as limiting, i.e., the base to which rates of return are computed and projects chosen to maximize the total return, can be seen in the following cells:

PVB (gross):	AG55 (gross benefits as entered line 15)
PVOC:	AG71 (present value of operating cost)
PV of Capital Cost:	AG92 (capital as entered line 37)
PVK:	AG165 (K = negative cash flow)
NPV:	AG96

line 96 -- if scarce resource costs were defined this way by entering 2 in cell E5)

$B/(OC + K)$: G134 (present value of benefit (cell AG55)/present value of total cost (cell AG93)). Cell AG93 is the present value of operating cost (PVOC) plus the present value of capital cost (PVK).

If policy suggests that only the years of negative cash flow requiring borrowing are limiting (regardless of the source of capital), the formula $(B - OC)/K$ is appropriate. The effects of ranking by the two criteria are shown by comparing projects with the two ratios above. If some source of capital such as state or Federal funding is considered limiting, the limiting source is entered as data on line 37 and the non-limiting source is entered as Operating Cost 2 on line 27. The non-limiting source is then netted from gross benefits and does not enter the denominator of any ratio.

HOW TO USE THE EXTENDED TEMPLATE

Follow the directions in "How to Use BENCOS." Note that you can go to any cell in Lotus 1-2-3 by pressing F5 and entering the appropriate letter and number of the cell coordinates. Computing (recalculation) must be done by pressing F9. Saving and printing your worksheet are done as described for BENCOS. Printing is initiated with a macro by pressing Alt-P.

ANNEX 1

1 | A | B | C | D | E | F | G | H | I | J | K | L | M |
 2 | * BENCOS ** By Ting-Ing Ho and Eric W. Crawford (Michigan State Univ.). Modified 5/88 by Beaver & Crawford
 3 | PARAMETERS SECTION || To print worksheet, press <ALT> P for menu.||
 4 | Interest Rate for Discounting = >> 0.15 << (Enter a decimal value)
 5 | Definition of Capital
 6 | or Scarce Resource Costs = >> 2 << (Enter 1 or 2 as described below)
 7 | (1): use rows 37 & 38; OR (2): use negative net cash flows from row 95

8 DATA SECTION
 9 *NOTE* You have two options for entering prices:
 10 (1) Enter price manually for each year;
 11 (2) Enter price in first year, and price compounding factor.

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Benefits							
13 Benefit 1:							
14 (constant scale factor = --)	units	--	0	4	5	6	7
15 (price compounding factor 1)	price	--	1	--	--	--	--
16 Benefit 2:							
17 (constant scale factor = --)	units	--	--	--	--	--	--
18 (price compounding factor --)	price	--	--	--	--	--	--
Costs							
22 Operating Cost 1:							
23 (constant scale factor = --)	units	--	5	1	1	1	--
24 (price compounding factor 1)	price	--	1	--	--	--	--
25 Operating Cost 2:							
26 (constant scale factor = --)	units	--	--	--	--	--	--
27 (price compounding factor --)	price	--	--	--	--	--	--
28 Production Cost 1:							
29 (constant scale factor = --)	units	--	0	2	2	2	--
30 (price compounding factor 1)	price	--	1	--	--	--	--
31 Production Cost 2:							
32 (constant scale factor = --)	units	--	--	--	--	--	--
33 (price compounding factor --)	price	--	--	--	--	--	--
34 Capital Cost(or Scarce Resource) 1:	--	--	--	--	--	--	--
35 Capital Cost(or Scarce Resource) 2:	--	--	--	--	--	--	--

40
41
42
43 OUTPUT SECTION(1)
44 Discount Factor (at 15 %)

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
44 Discount Factor (at 15 %)	1	0.869565	0.756143	0.657516	0.571753	0.497176	0.432327
Benefits							
45 Benefit 1: (units)	--	0.00	4.00	5.00	6.00	7.00	--
46 (price)	--	1.00	1.00	1.00	1.00	1.00	1.00
47 (price*scale)	--	1.00	1.00	1.00	1.00	1.00	1.00
48 (revenue)	0.00	0.00	4.00	5.00	6.00	7.00	0.00
49 Benefit 2: (units)	--	--	--	--	--	--	--
50 (price)	--	--	--	--	--	--	--
51 (price*scale)	--	--	--	--	--	--	--
52 (revenue)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
53 Total Benefits	0.00	0.00	4.00	5.00	6.00	7.00	0.00
54 Present Value of Benefits	0.00	0.00	3.02	3.29	3.43	3.48	0.00

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	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Costs							
62 Operating Cost 1: (units)	--	5.00	1.00	1.00	1.00	1.00	--
63 (price)	--	1.00	1.00	1.00	1.00	1.00	1.00
64 (price*scale)	--	1.00	1.00	1.00	1.00	1.00	1.00
65 (cost)	0.00	5.00	1.00	1.00	1.00	1.00	0.00
66 Operating Cost 2: (units)	--	--	--	--	--	--	--
67 (price)	--	--	--	--	--	--	--
68 (price*scale)	--	--	--	--	--	--	--
69 (cost)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
70 Total Operating Cost	0.00	5.00	1.00	1.00	1.00	1.00	0.00
71 Present Value of Operating Cost	0.00	4.35	0.76	0.66	0.57	0.50	0.00

	A	B	C	D	E	F	G	H	I	J	K	L	M
							Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
77													
78													
79								0.00	2.00	2.00	2.00	2.00	--
80								1.00	1.00	1.00	1.00	1.00	1.00
81								1.00	1.00	1.00	1.00	1.00	1.00
82							0.00	0.00	2.00	2.00	2.00	2.00	0.00
83													
84													
85													
86							0.00	0.00	0.00	0.00	0.00	0.00	0.00
87							0.00	0.00	2.00	2.00	2.00	2.00	0.00
88							0.00	0.00	1.51	1.32	1.14	0.99	0.00
89													
90													
91							0.00	0.00	0.00	0.00	0.00	0.00	0.00
92							0.00	0.00	0.00	0.00	0.00	0.00	0.00
93							0.00	5.00	3.00	3.00	3.00	3.00	0.00
94							0.00	4.35	2.27	1.97	1.72	1.49	0.00
95							0.00	-5.00	1.00	2.00	3.00	4.00	0.00
96							0.00	-4.35	0.76	1.32	1.72	1.99	0.00

97	SUMMARY						
98		Net Cash	Present Value at		15%		
99		Flow	Total	Total	Net	Interest	Net
100	Year	(line 95)	Benefit	Cost	Cash Flow	Rate	Present
101			(line 55)	(line 93)	(line 96)		Value
102							
103	0	0.00	0.00	0.00	0.00	0.05	3.48
104	1	-5.00	0.00	4.35	-4.35	0.10	2.32
105	2	1.00	3.02	2.27	0.76	0.15	1.43
106	3	2.00	3.29	1.97	1.32	0.20	0.74
107	4	3.00	3.43	1.72	1.72	0.25	0.20
108	5	4.00	3.48	1.49	1.99	0.30	-0.22
109	6	0.00	0.00	0.00	0.00	0.35	-0.55
110	7	0.00	0.00	0.00	0.00	0.40	-0.81
111	8	0.00	0.00	0.00	0.00	0.45	-1.01
112	9	0.00	0.00	0.00	0.00	0.50	-1.18
113	10	0.00	0.00	0.00	0.00	0.55	-1.31
114	11	0.00	0.00	0.00	0.00	0.60	-1.41
115	12	0.00	0.00	0.00	0.00	0.65	-1.49
116	13	0.00	0.00	0.00	0.00	0.70	-1.55
117	14	0.00	0.00	0.00	0.00	0.75	-1.59
118	15	0.00	0.00	0.00	0.00	0.80	-1.63
119	16	0.00	0.00	0.00	0.00	0.85	-1.65
120	17	0.00	0.00	0.00	0.00	0.90	-1.67
121	18	0.00	0.00	0.00	0.00	0.95	-1.68
122	19	0.00	0.00	0.00	0.00	1.00	-1.69
123	20	0.00	0.00	0.00	0.00	1.05	-1.69
124	21	0.00	0.00	0.00	0.00	1.10	-1.69
125	22	0.00	0.00	0.00	0.00	1.15	-1.68
126	23	0.00	0.00	0.00	0.00	1.20	-1.67
127	24	0.00	0.00	0.00	0.00	1.25	-1.66
128	25	0.00	0.00	0.00	0.00	1.30	-1.65
129						1.35	-1.64
130	TOTAL	5.00	13.22	11.80	1.43	1.40	-1.62
131						1.45	-1.61
132						1.50	-1.59
133	Gross B/C Ratio	=			1.12		
134	Net Benefit/Scarce Resource Cost Ratio	=			1.33		
135	Ratio of (Benefits - Production Costs)/						
136	(Operating + Capital Costs)	=			1.21		

138 -----
 139 Estimated Internal Rate
 140 of Return (IRR) at 5% interval = 0.274233 or 27.42%
 141 (If reported IRR > 145%, check NPV (cell J132). If NPV at 150% > 0, IRR > 150%.)
 142 -----

143 Estimated Internal Rate
 144 of Return (IRR) at 1% interval = 0.272780 or 27.28%
 145 -----

146 Internal Rate of Return (@IRR) = 0.272732 or 27.27%
 147 (** Valid only if benefits and costs start in year 1 **)
 148 -----
 149 -----

| AA || AB || AC || AD || AE || AF || AG || AH || AI || AJ |

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DATA SECTION

Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	TOTAL	
--	--	--	--	--	--	22	(Units, Benefit 1)
--	--	--	--	--	--	0	(Units, Benefit 2)
Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	TOTAL	
--	--	--	--	--	--	9	(Units, Op Cost 1)
--	--	--	--	--	--	0	(Units, Op Cost 2)
--	--	--	--	--	--	8	(Units, Prod Cost 1)
--	--	--	--	--	--	0	(Units, Prod Cost 2)
--	--	--	--	--	--	0	(Value, Capital Cost 1)
--	--	--	--	--	--	0	(Value, Capital Cost 2)

OUTPUT SECTION

Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	TOTAL	
0.061100	0.053130	0.046200	0.040174	0.034934	0.030377		
--	--	--	--	--	--	22.00	(Units, Benefit 1)
1.00	1.00	1.00	1.00	1.00	1.00		
1.00	1.00	1.00	1.00	1.00	1.00	22.00	(Revenue, Benefit 1)
0.00	0.00	0.00	0.00	0.00	0.00	0.00	(Units, Benefit 2)
--	--	--	--	--	--		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	(Revenue, Benefit 2)
0.00	0.00	0.00	0.00	0.00	0.00	22.00	(Total Benefit)
0.00	0.00	0.00	0.00	0.00	0.00	13.22	(PV of Benefit)

Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	TOTAL	
--	--	--	--	--	--	9.00	(Units, Op Cost 1)
1.00	1.00	1.00	1.00	1.00	1.00		
1.00	1.00	1.00	1.00	1.00	1.00	9.00	(Cost, Op Cost 1)
0.00	0.00	0.00	0.00	0.00	0.00	0.00	(Units, Op Cost 2)
--	--	--	--	--	--		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	(Cost, Op Cost 2)
0.00	0.00	0.00	0.00	0.00	0.00	9.00	(Total Op Cost)
0.00	0.00	0.00	0.00	0.00	0.00	6.83	(PV of Op Cost)

ANNEX 2

1 BENCOS/SCHMID--By Ting-Ing Ho, E. Crawford, and A. Schmid, Michigan State University Modified 6/88 by Beaver, Crawford, and Schmid
 2 PARAMETERS SECTION !! To print worksheet, press <ALT> P for menu.!! PART II - SUMMARY OF BENEFIT-COST ANALYSIS
 3 Interest Rate for Discounting = >> 0.08 << (Enter a decimal value) Terminal Year = >> 3 <<
 4 Definition of Capital PART II --> Interest Rate for Compounding Costs = >> 0.07 << (Enter a decimal value)
 5 or Scarce Resource Costs = >> 2 << (Enter 1 or 2 as described below) Interest Rate for Compounding Benefits = >> 0.08 << (Enter a decimal value)
 6 (1): use rows 37 & 38; OR (2): use negative net cash flows from row 95
 7

8 DATA SECTION

9 *NOTE* You have two options for entering prices:

- 10 (1) Enter price manually for each year;
- 11 (2) Enter price in first year, and price compounding factor.

		Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	... TOTAL	
13	Benefits									
14	Benefit 1:									
15	(constant scale factor = --)	units	--	--	100	128.1	--	--	228.1	(Units, Benefit 1)
16	(price compounding factor 1)	price	1	--	--	--	--	--		
17	Benefit 2:									
18	(constant scale factor = --)	units	--	--	--	--	--	--	0	(Units, Benefit 2)
19	(price compounding factor --)	price	--	--	--	--	--	--		
21		Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	... TOTAL	
22	Costs									
23	Operating Cost 1:									
24	(constant scale factor = --)	units	--	50	50	50	--	--	150	(Units, Op Cost 1)
25	(price compounding factor 1)	price	1	--	--	--	--	--		
26	Operating Cost 2:									
27	(constant scale factor = --)	units	--	--	--	--	--	--	0	(Units, Op Cost 2)
28	(price compounding factor --)	price	--	--	--	--	--	--		
30	Production Cost 1:									
31	(constant scale factor = --)	units	--	--	--	--	--	--	0	(Units, Prod Cost 1)
32	(price compounding factor --)	price	--	--	--	--	--	--		
33	Production Cost 2:									
34	(constant scale factor = --)	units	--	--	--	--	--	--	0	(Units, Prod Cost 2)
35	(price compounding factor --)	price	--	--	--	--	--	--		
37	Capital Cost(or Scarce Resource) 1:		54.55	--	--	--	--	--	54.55	(Value, Capital Cost 1)
38	Capital Cost(or Scarce Resource) 2:		--	--	--	--	--	--	0	(Value, Capital Cost 2)

40

	A	B	C	D	E	F	G	H	I	J	K	L	M	AG	AH	AI	AJ
							Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	... TOTAL			
42																	
43	OUTPUT SECTION(1)																
44	Discount Factor	(at	8 %)				1	0.925925	0.857338	0.793832	0.735029	0.680583	0.630169				
45	Benefits																
46	Benefit 1: (units)						--	--	100.00	128.10	--	--	--	228.10	(Units, Benefit 1)		
47	(price)						1.00	1.00	1.00	1.00	1.00	1.00	1.00				
48	(price*scale)						1.00	1.00	1.00	1.00	1.00	1.00	1.00				
49	(revenue)						0.00	0.00	100.00	128.10	0.00	0.00	0.00	228.10	(Revenue, Benefit 1)		
50	Benefit 2: (units)						--	--	--	--	--	--	--	0.00	(Units, Benefit 2)		
51	(price)						--	--	--	--	--	--	--				
52	(price*scale)						--	--	--	--	--	--	--				
53	(revenue)						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(Revenue, Benefit 2)		
54	Total Benefits						0.00	0.00	100.00	128.10	0.00	0.00	0.00	228.10	(Total Benefit)		
55	Present Value of Benefits						0.00	0.00	85.73	101.69	0.00	0.00	0.00	187.42	(PV of Benefit)		
56																	
57																	
58	-----																
59																	
60							Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	... TOTAL			
61	Costs																
62	Operating Cost 1: (units)						--	50.00	50.00	50.00	--	--	--	150.00	(Units, Op Cost 1)		
63	(price)						1.00	1.00	1.00	1.00	1.00	1.00	1.00				
64	(price*scale)						1.00	1.00	1.00	1.00	1.00	1.00	1.00				
65	(cost)						0.00	50.00	50.00	50.00	0.00	0.00	0.00	150.00	(Cost, Op Cost 1)		
66	Operating Cost 2: (units)						--	--	--	--	--	--	--	0.00	(Units, Op Cost 2)		
67	(price)						--	--	--	--	--	--	--				
68	(price*scale)						--	--	--	--	--	--	--				
69	(cost)						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(Cost, Op Cost 2)		
70	Total Operating Cost						0.00	50.00	50.00	50.00	0.00	0.00	0.00	150.00	(Total Op Cost)		
71	Present Value of Operating Cost						0.00	46.30	42.87	39.69	0.00	0.00	0.00	128.85	(PV of Op Cost)		
72																	
73																	
74																	
75	-----																
76	::																
77														... TOTAL			
78																	
79	Production Cost 1: (units)						--	--	--	--	--	--	--	0.00	(Units, Prod Cost 1)		
80	(price)						--	--	--	--	--	--	--				
81	(price*scale)						--	--	--	--	--	--	--				
82	(cost)						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(Value, Prod Cost 1)		
83	Production Cost 2: (units)						--	--	--	--	--	--	--	0.00	(Units, Prod Cost 2)		
84	(price)						--	--	--	--	--	--	--				
85	(price*scale)						--	--	--	--	--	--	--				
86	(cost)						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(Value, Prod Cost 2)		
87	Total Production Cost						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(Total Prod Cost)		
88	Present Value of Production Cost						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(PV of Prod Cost)		
89	Capital Cost 1						54.55	--	--	--	--	--	--	54.55	(Capital Cost 1)		
90	Capital Cost 2						--	--	--	--	--	--	--	0.00	(Capital Cost 2)		
91	Total Capital Cost						54.55	0.00	0.00	0.00	0.00	0.00	0.00	54.55	(Total Capital Cost)		
92	Present Value of Capital Cost						54.55	0.00	0.00	0.00	0.00	0.00	0.00	54.55	(PV of Capital Cost)		
93	Total Cost						54.55	50.00	50.00	50.00	0.00	0.00	0.00	204.55	(Total Cost)		
94	Present Value of Total Costs						54.55	46.30	42.87	39.69	0.00	0.00	0.00	183.40	(PV of Total Cost)		
95	Net Cash Flow						-54.55	-50.00	50.00	78.10	0.00	0.00	0.00	23.55	(Net Cash Flow (B-C))		
96	Present Value of Net Cash Flow						-54.55	-46.30	42.87	62.00	0.00	0.00	0.00	4.02	(PV of Net Cash Flow)		
97	-----																

	A	B	C	D	E	F	G	H	I	J	K	L	M	AG	AH	AI	AJ	AK
97																		
98	SUMMARY - OUTPUT I			Present Value at			5%											
99																		
100																		
101			Net Cash		Total	Total	Net											
102	Year		Flow		Benefit	Cost	Cash Flow		Interest		Net							
103			(line 95)		(line 55)	(line 94)	(line 96)		Rate		Present							
104	0		-54.55		0.00	54.55	-54.55		0.05		10.65							
105	1		-50.00		0.00	46.30	-46.30		0.10		0.00							
106	2		50.00		85.73	42.87	42.87		0.15		-8.87							
107	3		78.10		101.69	39.69	62.00		0.20		-16.30							
108	4		0.00		0.00	0.00	0.00		0.25		-22.56							
109	5		0.00		0.00	0.00	0.00		0.30		-27.88							
110	6		0.00		0.00	0.00	0.00		0.35		-32.41							
111	7		0.00		0.00	0.00	0.00		0.40		-36.29							
112	8		0.00		0.00	0.00	0.00		0.45		-39.63							
113	9		0.00		0.00	0.00	0.00		0.50		-42.52							
114	10		0.00		0.00	0.00	0.00		0.55		-45.02							
115	11		0.00		0.00	0.00	0.00		0.60		-47.20							
116	12		0.00		0.00	0.00	0.00		0.65		-49.10							
117	13		0.00		0.00	0.00	0.00		0.70		-50.76							
118	14		0.00		0.00	0.00	0.00		0.75		-52.22							
119	15		0.00		0.00	0.00	0.00		0.80		-53.50							
120	16		0.00		0.00	0.00	0.00		0.85		-54.63							
121	17		0.00		0.00	0.00	0.00		0.90		-55.63							
122	18		0.00		0.00	0.00	0.00		0.95		-56.51							
123	19		0.00		0.00	0.00	0.00		1.00		-57.29							
124	20		0.00		0.00	0.00	0.00		1.05		-57.98							
125	21		0.00		0.00	0.00	0.00		1.10		-58.59							
126	22		0.00		0.00	0.00	0.00		1.15		-59.13							
127	23		0.00		0.00	0.00	0.00		1.20		-59.61							
128	24		0.00		0.00	0.00	0.00		1.25		-60.04							
129	25		0.00		0.00	0.00	0.00		1.30		-60.42							
130									1.35		-60.75							
131		TOTAL	23.55		187.42	183.40	4.02		1.40		-61.05							
132									1.45		-61.32							
133									1.50		-61.55							
134		Gross B/C Ratio		=			1.02											
135		Net Benefit/Scarce Resource Cost Ratio		=			1.04											
136		Ratio of (Benefits - Production Costs)/																
137		(Operating + Capital Costs)		=			1.02											
138																		
139																		
140		Estimated Internal Rate																
141		of Return (IRR) at 5% interval =	0.099979	or			10.00%											
142		(If reported IRR > 145%, check NPV (cell J133). If NPV at 150% > 0, IRR > 150%.)																
143																		
144		Estimated Internal Rate																
145		of Return (IRR) at 1% interval =	0.099977	or			10.00%											
146																		
147		Internal Rate of Return (@IRR)		=	NA	or	NA											
148		** Valid only if benefits and costs start in year 1 **)																
149																		
150																		

	A	B	C	D	E	F	G	H	I	J	K	L	M	AG	AN	AI	AJ	AK
151 ::																		
152 OUTPUT SECTION(II)																		
153							0	1	2	3	4	5	6	...	TOTAL			
154	Compound Factor (Costs at				7.00%		1.23	1.14	1.07	1.00	0.93	0.87	0.82					
155	Discount Factor at				7.00%		1.00	0.93	0.87	0.82	0.76	0.71	0.67					
156	Compound Factor (Benefits at				8.00%		1.26	1.17	1.08	1.00	0.93	0.86	0.79					
157	Terminal Value of Benefits (line 14)						0.00	0.00	108.00	128.10	0.00	0.00	0.00	236.10				(Terminal Value of Benefits)
158	Terminal Value of Operating Cost (lines 23,26)						0.00	57.25	53.50	50.00	0.00	0.00	0.00	160.75				(Terminal Value of Operating Cost)
159	Terminal Value of Total Production Cost (lines 30,33)						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				(Terminal Value of Production Cost)
160	Terminal Value of Total Capital Cost (line 37)						66.83	0.00	0.00	0.00	0.00	0.00	0.00	66.83				(Terminal Value of Capital Cost)
161	Terminal Value of Total Costs (lines 23+26+30+33+37)						66.83	57.25	53.50	50.00	0.00	0.00	0.00	227.57				(Terminal Value of Total Costs)
162	Terminal Value of Net Cash Flow						-66.83	-57.25	54.50	78.10	0.00	0.00	0.00	8.53				(Terminal Value of Net Cash Flow)
163	Terminal Value of Negative Cash Flow						-66.83	-57.25	0.00	0.00	0.00	0.00	0.00	-124.07				(Terminal Value of Negative Cash Flow)
164	Terminal Value of Positive Cash Flow at				8.00%		0.00	0.00	54.50	78.10	0.00	0.00	0.00	132.60				(Terminal Value of Positive Cash Flow)
165	Present Value of Negative Cash Flow at				7.00%		-54.55	-46.73	0.00	0.00	0.00	0.00	0.00	-101.28				(Net Present Value of Negative Cash Flow)

167 SUMMARY - OUTPUT II Estimated Normalized Internal
 168 ----- Rate of Return (NIRR)

169	Year	Normalized Net Cash Flow	Interest Rate	Net Present Value
170				
171	0	-101.28	0.05	13.27
172	1	0.00	0.10	-1.65
173	2	0.00	0.15	-14.09
174	3	132.60	0.20	-24.54
175	4	0.00	0.25	-33.39
176	5	0.00	0.30	-40.92
177	6	0.00	0.35	-47.38
178	7	0.00	0.40	-52.96
179	8	0.00	0.45	-57.78
180	9	0.00	0.50	-61.99
181	10	0.00	0.55	-65.67
182	11	0.00	0.60	-68.91
183	12	0.00	0.65	-71.76
184	13	0.00	0.70	-74.29
185	14	0.00	0.75	-76.54
186	15	0.00	0.80	-78.54
187	16	0.00	0.85	-80.34
188	17	0.00	0.90	-81.95
189	18	0.00	0.95	-83.40
190	19	0.00	1.00	-84.70
191	20	0.00	1.05	-85.89
192	21	0.00	1.10	-86.96
193	22	0.00	1.15	-87.94
194	23	0.00	1.20	-88.83
195	24	0.00	1.25	-89.64
196	25	0.00	1.30	-90.38
197		-----	1.35	-91.06
198		31.32	1.40	-91.69
199			1.45	-92.26
200			1.50	-92.79
201				
202				
203				

	A	B	C	D	E	F	G
203							
204	Terminal Value of Net Benefit	=				8.53	
205	Gross Terminal B/C Ratio	=				1.04	
206	Net Benefit/Scarce Resource Cost Ratio	=				1.07	
207	Ratio of (Benefit - Production Costs)/						
208	(Operating + Capital Costs)	=				1.04	
209							
210	P. V.(at 8.00%) of Terminal Value Total Benefits	=				187.42	
211	P. V.(at 7.00%) of Terminal Value Total Costs	=				185.77	
212	Present Value Ratio of Gross B/C	=				1.01	
213	Net Present Value of Terminal Value of Net Benefit:						
214	(at rate used to compound costs)	=				6.96	
215	(at rate used to compound benefits)=					6.77	
216	-----						
217	Estimated Normalized Internal Rate						
218	of Return (NIRR) at 5% interval = 0.094455	or				9.45%	
219	(if reported NIRR > 145%, check NPV (cell F202). If NPV at 150% > 0, NIRR > 150%.)						
220	-----						
221	Estimated Normalized Internal Rate						
222	of Return (NIRR) at 1% interval = 0.094021	or				9.40%	
223	-----						
224	Normalized IRR (NIRR)	=			NA	or	NA
225	(** Valid only if benefits and costs start in year 1 **)						
226	-----						
227	-----						

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